STRATEGIC DESIGN RESEARCH JOURNAL

Strategic Design Research Journal, 11(2): 58-64 May-August 2018
Unisinos – doi: 10.4013/sdrj.2018.112.02

Practice-based ontological design for multiplying realities

Christian Nold
christian@softhook.com
University College London. Department of Geography. Pearson Building, Gower Street
WC1E 6BT, London, United Kingdom

ABSTRACT

This text argues that a practice-based notion of ontological design is useful for designers to transform the politics of the already designed world. The text analyzes three approaches to the philosophical concept of ontology and suggests that a Science and Technology Studies approach focused on observing ontologies in practice provides pragmatic potential for designers to intervene in public controversies. The author's case study of a contested airport expansion demonstrates that this approach can sensitize the designer to multiple realities, identify 'where' the ontological infrastructure of a problem is located, and define 'what' design is needed to transform a controversy. The text uses these findings to propose principles of practice-based ontological design that can support designers who are seeking to transform the world into a series of situated controversies.

Keywords: ontological design, ontological politics, design interventions

Introduction: searching for a new kind of design

This text joins a growing movement for political design that can transform the world and move beyond commercial and functionalist imperatives. This can be seen in approaches such as adversarial design (DiSalvo, 2012), critical making (Ratto *et al.*, 2014) and participatory design that is engaging with public issues beyond the workplace (Björgvinsson *et al.*, 2012). This text explores the conceptual foundations of these forms of design. Should they be based on moral commitments to create a 'better world' or rather a sensitivity towards design as opening-up and foreclosing realities in practice? To explore this question, I focus on the notion of ontology as an impetus for new political design practices that have been termed 'ontological design' by Escobar (2015) and Fry (2017). The authors argue that design is implicated in contemporary social and environmental crises and that the existing models for design are at fault; "the crisis thus stems from the models through which we imagine the world to be a certain way and construct it accordingly" (Escobar, 2015, p. 15). Their argument is that modernist approaches to design are at the core of ecological and social crises due to the way they reinforce divisions between mind and body (Escobar, 2013, p. 35) and the human and nature (Escobar, 2015). Instead, Escobar suggests that design should be a collective social process that includes everyone and involves all forms of human making from the mundane to the most extravagant (Escobar, 2017). Fry and Escobar argue that to build a better world requires alternative ontological models; "it is about the making of 'worlds and knowledges otherwise', that is, worlds and knowledges constructed on the basis of different ontological commitments" (Escobar, 2013, p. 34). By replacing modernist design with new ontological commitments, they hope this will correct the imbalance between the Global North and South and create new forms of autonomy and collectivity.

While I am sympathetic towards these aims, I argue that Fry and Escobar's vision of ontological design is not specific or pragmatic enough to help designers in transforming the world. My contribution in this text is to examine the way Fry and Escobar use the notion of 'ontology' and propose an alternative vision based around an 'ontological turn' within Science and Technology Studies (STS) where ontology is used as a destabilizing concept to narrate how material objects enact realities in practice. This approach suggests that design can perform multiple realities as everyday practices via sociomaterial devices.

The text makes a proposal for a practice-based ontological design that can support designers in engaging with normative questions about which forms of reality are better to design. This approach is illustrated via my own case study of a public controversy of Heathrow Airport in London. In this example, an ontological design intervention made it possible to multiply noise realities and create impacts on the continuation of the controversy. From this study, the paper extracts three principles for practice-based ontological design. The benefit of this approach is that it sensitizes the designer towards multiple realities

and identifies new sites for design that were previously invisible. In this way, practice-based ontological design can provide pragmatic foundations for the growing movement of political design.

Three notions of ontology

To start, I provide an overview of a number of different understandings of ontology in relation to design; but a comprehensive analysis is beyond the scope of the paper. The term ontology derives from the Greek '*ontos*' meaning 'being - that which is' and '*logia*' meaning 'logical discourse'. Thus, since the 17th century, discussions about ontology have been philosophical discourses about the nature of being and reality. The following section sketches three notions of ontology and how they might be relevant for design.

The first explicit connection between design and ontology was made by Winograd and Flores (1990, p. xi), who suggest that "in designing tools we are designing ways of being". The argument is that human nature has always been shaped by the tools we use. Historically, many studies have suggested that by harnessing fire as a tool for cooking, prehistoric humans changed the size and development of their brain (Leonard *et al.*, 2003). By creating material objects humans are thus remaking the reality of being human. Following this logic, ontological design is the process of embedding intension into material, with designed objects acquiring an independent 'being' from the designer which in turn affects the designer:

> *A knife is a designed thing that directs itself towards cutting. This is stronger than saying it has been designed to allow the user to cut with it - that formulation posits all intention with the human user and obliterates the being of the knife as 'cuttingness' (Willis, 2006, p. 83).*

Essentially, designed objects are entities that also come to shape us. Winnograd, Flores, Willis, Fry, and Escobar all describe design as a circular process that loops back onto the designer. "Ontological design is the 'designing of the being of something brought into being' by design or 'of itself' (which is to say all that is designed goes on designing)" (Fry, 2017, p. 26). In this looping process, knowledge is inscribed into a tool which in turn modifies the being of the tool-user who then continues the process. Fry and Escobar suggest that it is possible and necessary to intervene in this design loop by inserting a set of 'ontological commitments' in order to change the ultimate destination of this process. Thus Escobar asks, "can we imagine design ontologies that are deeply relational?" (Escobar, 2013, p. 75). The way Fry and Escobar use the words 'relational' and 'communal' is as metaphysical categories that are conceived of as lying 'beneath' design. This means the material design object is treated as less foundational than these concepts. Winnograd, Flores, Willis, Fry, and Escobar all derive this understanding of ontology from Heidegger's 'Being and Time' (Heidegger, 2010 [1927]), who postulates that there are structural modes of caring for the world. The authors adopt Heidegger's 'modes of being' in order to build new metaphysical foundations that can guide design towards a better world.

As well as metaphysical, I suggest we should also think of Fry and Escobar's ontological commitments as ideological. I want to highlight the normative way the authors want to sign up designers to a program of pledges that constitute a kind of moral code of how-to-do design. 'Ideological' is also an apt term for the elusive and immaterial nature of these diktats. While Fry and Escobar provide a series of inspirational vignettes in their texts, they do not offer concrete examples of ontological design in practice. This makes it hard to imagine how a commitment to 'be relational' would function in practice and how it would reconcile practical contradictions. For example, how should a designer deal with a conflict between a commitment to support an indigenous community and a commitment 'not to separate humans from nature'? This lack of definition means it is not clear how ontological commitments are different from more familiar arguments for 'user-centered design' (Abras *et al.*, 2004). As many social science studies have shown, 'the user' is not a definitive agent but is configured differently in practice based on a whole variety of pressures (Oudshoorn and Pinch, 2006; Suchman, 2007). My point is that postulating something as 'user-centered' or 'relational' doesn't necessarily guarantee positive or predictable outcomes. My suggestion is that Fry and Escobar's use of ontology as metaphysical commitments may not be sufficiently grounded or pragmatic. The danger is that such commitments might become mere platitudes.

The second encounter between design and ontology is within computer science. In this context, ontology is used to mean a practical construction of taxonomic schemes. A typical use is the encoding of categories and organizational schemes into the structure of a database. In this vein, Ramaprasad and Papagari (2009) describe ontological design as a way to "standardize terminologies, map requirements, organize them systematically, facilitate integration of systems, promote knowledge exchange" (5:1). In this approach, ontology is treated as a descriptive vocabulary of reality that can be re-designed to make information systems function better. Unlike the first conception of ontology, this approach treats ontologies as problem-specific rather than universal. In the computer science conception, making an ontology involves merely creating a representation rather than changing reality itself. Yet, material reality is provided with no agency to push-back against the processes of categorizations carried out by a designer. In this framing, ontology loses its potential as a political encounter that can transform the world. I suggest this reductive conception of ontology is not helpful for providing a normative impetus for tackling ecological or societal crises.

This brings me to the third approach to ontology within Science and Technology Studies (STS). STS is a diverse and interdisciplinary field that explores the relationship between science, technology, and social actors. STS researchers explore the way technologies (Pinch and Bijker, 1984) and scientific knowledge (Wynne, 1996) are constructed. This often involves ethnographically observing processes within laboratories (Latour, 1987; Suchman, 2007). My focus is on a specific part of STS that emerged in the last decade and has been called a 'turn to ontolo-

gy' (Mol, 2002; Law and Lien, 2013; Woolgar and Lezaun, 2013). It aims to challenge the notion that there is a single reality and instead involves observations of multiple realities that take place within local sites. It uses the term ontology to destabilize what counts as reality:

> *Ontology is a deliberately unstable term or category in STS. This is not only because it lacks a precise meaning or definitive qualifier but because the term itself is introduced with the intention of destabilizing seemingly robust designations of reality. The point of a turn to ontology in STS is to sharpen a contrast between alternative strategies of description (Woolgar and Lezaun, 2015, p. 463).*

The argument is that ontology is not a stable description of the world but that ontologies are everyday practices: "ontology is not given in the order of things, but that, instead, ontologies are brought into being, sustained, or allowed to wither away in common, day-to-day, sociomaterial practices" (Mol, 2002, p. 6). By sociomaterial practices, Mol means that material devices and social processes function together to create realities. In her research of hospitals, she suggests that medical instruments and techniques make reality differently: "here it is being cut into with a Scalpel; there it is being bombarded with ultrasound; and somewhere else, a little further along the way, it is being put on a scale in order to be weighed" (Mol, 1999, p. 77). Thus, different techniques and instruments create different realities. This means under a microscope a disease looks like a narrowing of arteries while behaving completely differently in patient consultations, clinicians' observations or radiologists' visualizations. The suggestion is that there is not a single reality but that multiple realities are 'performed' or 'enacted' simultaneously. While this may appear similar to Winograd and Flores' (1990) suggestion that designers are shaping reality, in Mol's analysis, designers are materially multiplying the number of possible realities in everyday ways. The difference is one of scale, where rather than talking about design as remaking the human condition, Mol's realities are much more specific and local. They are also multiple and subject to change and thus raise the possibility of normatively choosing between different realities.

Within STS, the 'turn to ontology' has been productive for reopening classic STS topics of knowledge and expertise controversies (Wynne, 1996) and transforming them into something that researchers can intervene into (Whatmore, 2013). This approach often highlights the way multiple ontologies collide with each other or a resolved as ontological politics:

> *Ontological politics is a composite term. It talks of ontology - which in standard philosophical parlance defines what belongs to the real, the conditions of possibility we live with. If the term ontology is defined with that of politics, then this suggests that the conditions of possibility are not given. That reality does not precede the mundane practices in which we interact with it, but is rather shaped within these practices. So the term politics works to underline this active mode, this process of shaping, and the fact that its character is both open and contested (Mol, 1999, p. 74-75).*

Ontological politics is a means of describing how reality is done in practice and 'which' realities become enacted at the expense of other realities. In Mol's case studies, ontological politics is the way conflictual ontologies interact in order to make the everyday practices of medical care 'doable' and establish "what counts as the reality in a particular site" (Mol, 2002, p. 48). The way conflictual ontologies are managed can have a significant positive or negative impact on the care of patients. Woolgar and Lezaun (2013) suggest this ontological approach is a way of sensitizing the researcher towards alternatives and detecting "the failed, unseen or not-yet-real possibilities hinted at by ordering practices" (p. 323). Ontological politics raises normative questions about which realities are better. Mol suggests we should be asking questions such as "Where are the options? What is at stake? Are there really options? How should we choose?" (Mol, 1999, p. 79) and, in another text, "which version might be better to live with? Which worse? How, and for whom?" (Mol, 2013, p. 381). Crucially these are not metaphysical but political questions. They ask about the pragmatic possibilities for specific contexts and challenge the researcher and designer to identify who is affected, what is at stake, and which routes are better to go down. John Law argues that this means the researcher has to 'interfere' or 'intervene' in their case studies to make normative choices to improve the situation they are studying. He suggests, "in an ontological politics we might hope, instead, to interfere, to make some realities realer, others less so. The good of making a difference will live alongside - and sometimes displace - that of enacting truth" (Law, 2004, p. 67). The argument is that the role of the researcher (or designer) is not the search for truth but to actively 'make some realities realer'.

Having outlined these different understandings of ontology, I suggest a practice-based notion of ontology from STS offers strong potential for politically transformative design. This approach sees sociomaterial design as enacting multiple realities. Instead of metaphysical commitments, this presents a pragmatic focus on everyday practices that allow political choices to be made between multiple realities.

Ontological design in practice

So how can one do practice-based ontological design? I suggest this is a two-part process of research followed by interventions. Marc Berg (1998) suggests that an ontological design approach requires "immersing oneself in the networks described and searching for what is or can be achieved by new interlockings of artifacts and human work" (p. 482). The suggestion is that designers start by analyzing the existing networks and ontologies that are at work in a problem. This is followed by design interventions that Noortje Marres describes as: "the deliberate investment of non-humans with moral and political capacities. Here objects, and by extension ontologies, have political and moral capacities 'by design'" (Marres, 2013, p. 12). Once the existing ontologies of a setting have been iden-

tified, designers should build design artifacts that have deliberate '*moral and political capacities'* in order to carry out interventions into these networks. Together these quotes provide theoretical guidance for how to do practice-based ontological design, but a case study will add more clarity.

I provide a sketch of my own case study of using ontological design in relation to Heathrow Airport in London (UK). The study involved long-term ethnographic research with local residents, pressure groups and representatives from local government and institutional agencies which was then followed by practical micro/macro prototyping (Nold, 2015). I present the case study divided into two parts. The initial part illustrates how to carry out ontological analysis of a problem while the latter part shows how hands-on design methods can be used to intervene ontologically. The aim is to highlight how practice-based ontological design can sensitize the researcher to multiple realities and identify 'where' and 'what' to design. A more detailed account of this study can be found in my Ph.D. thesis (Nold, 2017) and book chapter (Nold, 2018).

In this first part of the case study, I present contextual information for the reader to understand the study and to illustrate the research process that was involved in analyzing Heathrow as an ontological problem and to identify its infrastructure. Heathrow is the world's third largest airport, with 73.4 million passengers every year (Heathrow Airport, 2015), which results in London receiving the highest aircraft noise exposure in Europe. Yet there are currently advanced plans to expand the airport with a third runway that is estimated to generate £147 billion in additional Gross Domestic Product; but is also expected to increase the noise and air pollution for residents (Airports Commission, 2015). In the popular media, the decision of whether to expand the airport is discussed as a choice between economic benefits for the country versus the annoyance and disturbance suffered by a few local residents. The issue is framed as a political trade-off between different constituencies of the electorate. Yet, local residents argue this is an environmental justice issue, with them receiving the pollution, while the economic benefits are going to others. In many ways, this is a familiar story of industrial problems in modern capitalist society. Typically, these controversies are handled by institutional processes and involve politicians and representatives from industries and spokespeople of affected groups. While this is clearly a political controversy, it is also a problem that design can transform. A modernist design approach might focus on the material infrastructure such as the aircraft to make them more efficient and less polluting. While this is worthwhile, this case study demonstrates that practice-based ontological design can do something different and identify surprising sites for design. The airport consists of a material infrastructure of runways as well as an institutional infrastructure of representatives, but the controversy also has an ontological infrastructure that enables and prohibits particular realities. I derive this concept of an ontological infrastructure from Star and Ruhleder's notion of relational infrastructure (Star and Ruhleder, 1996).

Aircraft noise first emerged as an issue in Heathrow with the introduction of turbo-jet aircraft in 1958, which led the government to commission a study in 1961 to analyze the impact of aircraft noise on humans. This and a number of subsequent studies all involved interviews with small numbers of residents who were asked how bothered they were by acoustic noise. The results from these studies were used to create a metric and define a noise threshold at which community annoyance was said to occur. This threshold was plotted as a spatial contour radiating from the airport, and those living within it were officially defined as experiencing annoyance; while those outside were not. The number of people living within the contour became the key metric for the number of people affected by the airport. From its origins in the 1960s, the aim of these metrics was to function as a policy instrument for "estimating the disturbance resulting from a change in the scale or pattern of airport operations, or from a new airport" (Brooker *et al.*, 1985, p. 1). For the government, this annoyance metric served as the main calculative infrastructure to aggregate the individual experiences of residents into a number that could be used to predict the impact of expanding the airport. Today the number of affected people (as calculated by the metric) is used as the main indicator within the Airports Commission report (Airports Commission, 2015) when deciding whether to build the third runway. However, local residents are frustrated with the way community annoyance is used by the government and the airport to speak on their behalf. Here is one resident's response to the Airports Commission:

> *Heathrow are also exploiting the 57dB noise threshold to make it look like there is a reduction in noise with an expanded airport. The reality of course is that noise continues to be hugely disturbing to many people considerably below that threshold, me included. Where I currently live whilst better than Kew (hence I moved here) and just outside the 57dB contour is still disturbing enough to wake my children regularly (Airports Commission, 2013).*

As the extract shows, the metric does not function well at encompassing collective annoyance and delegitimizes individuals from speaking about their experience. The metric and contour act ontologically to define people's reality and politically to make decisions about airport expansion. Thus, I suggest the annoyance metric is the key ontological infrastructure of the Heathrow controversy. This infrastructure mediates between the aircraft, local residents and the legislative authorities that govern the experiential impact of noise pollution. Yet in the mainstream media, the metric is treated largely as a technical matter and hardly mentioned. While in the academic literature, acousticians admit that these metrics are constructed as "a matter of convenience" rather than objective statements of reality (Flindell, 2003, p. 36). This suggests that it might be possible to design a whole range of other metrics that can better represent the reality of noise for local people. For example, the acoustician Fidell proposes that networked computing devices could be built as a citizen reporting system to replace the annoyance metric as a spokesperson for the experience of the residents (Fidell, 2003).

This first part of the case study has illustrated the research involved in analyzing a public controversy to

identify its ontological infrastructure. This involved historical research as well as interviews with stakeholders and ethnographic observations of life in Heathrow. This approach highlighted the metric as a site of ontological conflict and sensitized me as a researcher to the multiple realities that are at stake. The metric as ontological infrastructure is largely invisible to the public and not reported in the media who focus on the economic and political arguments. Crucially, this analysis managed to translate the public controversy of noise at Heathrow into an ontological design problem that can be directly targeted. Thus, it identified the annoyance metric as the 'object or site' that requires redesign.

The second part of the study outlines how ontological design was used as a practical method for exploring 'what' to design in order to multiply realities. This took place via participatory design workshops with local residents and a pressure group and involved the design of five prototypes. Each prototype was an ontological proposition about the relationship between aircraft, residents, and governance and carried 'moral and political capacities' (Marres, 2013). The aim was not to seek approval for the prototypes but to allow the participants to experience and articulate new infrastructural propositions to challenge the existing annoyance metric. One prototype was programmed to send an SMS message whenever a loud aircraft was detected overhead (Figure 1). The prototype asked the question as to who should receive the constant stream of SMS messages and be held directly responsible for the aircraft noise. Each of the prototypes was a provocation for a different way of handling noise and offered an alternative to the annoyance metric. The workshops highlighted that the diversity of the resident group required devices that would support multiple ontologies of affectedness. The main result of the workshops was the gathering of a local noise-monitoring network. Over a period of years, I assembled a network that included a charitable foundation, a local council and a noise pressure group as well as individual local residents, sound artists, students and academics working on noise and biodiversity. The final prototype I built for this noise monitoring network deliberately merged two ontologies into a single device. It combined an ontology of sound as measurable decibel data using the official noise standard as well as transmitting the sound of the aircraft as an audible soundscape. These physical prototype devices were hosted in people's gardens and have collected more than two years of data. The data has been used by the participants to make official complaints about out-of-hour flights and to produce longitudinal evidence to challenge the airport's claim that it is getting quieter. The devices have also supported two artistic sound installations where people who were unfamiliar with the noise controversy could listen in real-time to the aircraft to compare noise at sites inside and outside the annoyance contour. This project is still ongoing and will soon result in a collaborative report that will propose alterative metrics of wellbeing at Heathrow.

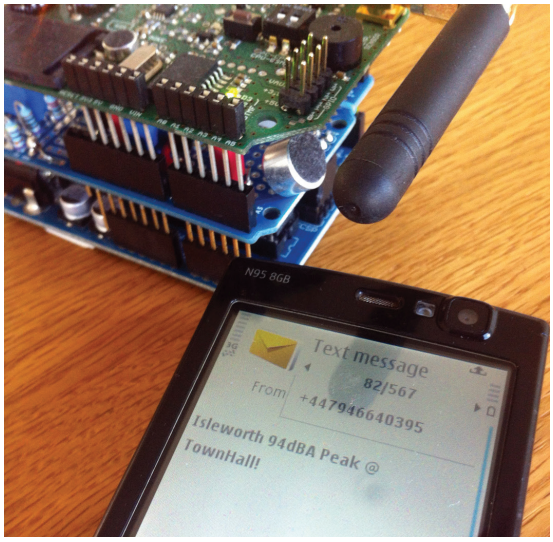

Figure 1. The 'I make someone responsible' prototype which sends an SMS message whenever it detects a loud aircraft overhead.

Discussion

This paper has addressed the search for political design that can deal with the crises created by modernist design. In particular, it explored the foundations for these new forms of design. While Fry and Escobar propose ontological design should be based on ideological and metaphysical commitments towards 'relationality' and 'communality', this paper argues that commitments are not easily translatable into practice. In contrast, the paper used theory from the ontological turn in STS to propose practice-based ontological design that involves analyzing the way realities are enacted in practice in order to intervene. The case study has demonstrated the value of identifying the ontological infrastructure of a controversy, since without this approach, the pivotal role of the annoyance metric would be hidden. This approach thus identified 'where' to design and intervene. The case study also illustrated that an ontological approach could be combined with participatory design to collectively define 'what' kinds of design were needed to support local collectives. The case study thus demonstrates that being sensitized to multiple ontologies can function as a pragmatic way to design in relation to complex contexts.

I suggest this practice-based ontological approach is in tune with a broader convergence taking place between STS and design. This can be seen in the emergence of the designer as ethnographer (Wilkie, 2010; Kerridge, 2015), the critical making approach (Ratto *et al.*, 2014) as well as participatory design that is taking place beyond the workplace (Ehn, 2008; Björgvinsson *et al.*, 2012; Le Dantec, 2012; DiSalvo *et al.*, 2014). These designers are using ethnographic observations and aiming to support communities through normative engagement with public controversies. Practice-based ontological design can contribute to these approaches by moving away from the human community as the focus of participatory design and highlighting controversies as having ontologies that are enacted through sociomaterial elements. In particular, this approach can sensitize designers to the multiplicity of realities and offer a practical method for situating interventions.

The paper proposes three principles:

- Practice-based ontological design can sensitize the designer to everyday life as a site of politics where multiple realities are at stake.
- Practice-based ontological design can identify the ontological infrastructures of problems and thus identify 'where' to design.
- Practice-based ontological design can be integrated with participatory approaches to collectively define 'what' designs should be implemented.

More broadly, I propose that practice-based ontological design may offer a way of tackling the social and ecological crises and Global North and South inequalities that Fry and Escobar highlight. Instead of concentrating on the global scale, a focus on practice can transform the scope of problems to make them specific to someone and local to somewhere. Practice-based ontological design can be used to translate crises into many situated controversies that are tackled in a distributed and horizontal way by situated actors. This specificity is where this approach is strongest. Instead of seeking foundations for political design in morality or metaphysics it is rooted in the practice of everyday life. This allows designers to observe the malleability of realities within local controversies and creates unexpected possibilities for intervention and coalitions that are not visible from a macro level. Making problems specific allows designers to position themselves as embodied actors within a problem and sensitizes them to the realities at stake and develop solidarities. This involvement may lead to a desire to intervene and improve situations in order to make some realities 'more real'. In this way, a horizontal adoption of practice-based ontological design could support new forms of political design that translate global challenges into situated controversies where designers and affected communities can tackle them together.

Acknowledgments

This research has been supported by the European Commission via the DITOs project under the grant agreement No. 709443 as well as EU RD contract IST-265432 and the EPSRC Institutional Sponsorship awards to UCL 2011-12 (Grant References EP/J501396/1 & EP/K503459/1). It was also supported as part of the Hubbub project investigating rest and its opposites, supported by the Wellcome Trust [103817/Z/14/Z].

References

ABRAS, C.; MALONEY-KRICHMAR, D.; PREECE, J. 2004. User-Centered Design. *In:* W.S. BAINBRIDGE (ed.), *Berkshire Encyclopedia of Human-Computer Interaction*. Great Barrington, Berkshire Publishing Group, p. 763-768.

AIRPORTS COMMISSION. 2013. Member of the public 16: Noise discussion paper. gov.uk. Available at: https://www.gov.uk/government/publications/stakeholder-responses-to-airports-commission-discussion-papers. Accessed on: 12/15/2015.

AIRPORTS COMMISSION. 2015. Airports Commission: Final Report. Available at: https://www.gov.uk/government/publications/airports-commission-final-report. Accessed on: 08/04/2017.

BERG, M. 1998. The Politics of Technology: On Bringing Social Theory into Technological Design. *Science, Technology & Human Values*, **23**(4):456-490. https://doi.org/10.1177/016224399802300406

BJÖRGVINSSON, E.; EHN, P.; HILLGREN, P-A. 2012. Agonistic participatory design: working with marginalised social movements. *CoDesign*, **8**(2-3):127-144. https://doi.org/10.1080/15710882.2012.672577

BROOKER, P.; CRITCHLEY, J.B.; MONKMAN, D.J.; RICHMOND, C. 1985. Aircraft Noise Index Study: main report. Available at: https://publicapps.caa.co.uk/docs/33/ERCD%208402.PDF. Accessed on: 04/15/2018.

DISALVO, C. 2012. *Adversarial Design*. Cambridge/London, MIT Press, 145 p.

DISALVO, C.; LODATO, T.; JENKINS, T.; LUKENS, J.; KIM, T. 2014. Making public things: how HCI design can express matters of concern. *In:* Conference on Human Factors in Computing Systems, Toronto, 2014. *Proceedings...* SIGCHI, p. 2397-2406. https://doi.org/10.1145/2556288.2557359

EHN, P. 2008. Participation in Design Things. *In:* Conference on Participatory Design, 10, Bloomington, Indiana, 2008. *Proceedings...* p. 92-101.

ESCOBAR, A. 2013. Notes on the ontology of design. Available at: http://sawyerseminar.ucdavis.edu/files/2012/12/ESCOBAR_Notes-on-the-Ontology-of-Design-Parts-I-II-_-III.pdf. Accessed on: 08/04/2017.

ESCOBAR, A. 2015. Transiciones: a space for research and design for transitions to the pluriverse. *Design Philosophy Papers*, **13**(1):13-23. https://doi.org/10.1080/14487136.2015.1085690

ESCOBAR, A. 2017. Arturo Escobar: Designs for the Pluriverse. Clark University Atwood Lecture. Wallace W. Atwood Lecture. Available at: https://www.youtube.com/watch?v=8Ouy7aN6XPs Accessed on: 12/12/2017.

FIDELL, S. 2003. The Schultz curve 25 years later: A research perspective. *The Journal of the Acoustical Society of America*, **114**(6):3007-3015. https://doi.org/10.1121/1.1628246

FLINDELL, I.H. 2003. Do public inquiries for noise control serve a useful purpose? An acoustic consultant's view. *Noise & Health*, **5**(18):31-38.

FRY, T. 2017. Design for/by 'The Global South'. *Design Philosophy Papers*, **15**(1):3-37. https://doi.org/10.1080/14487136.2017.1303242

HEATHROW AIRPORT. 2015. HeathrowFacts and figures. Available at: http://www.heathrowairport.com/about-us/company-news-and-information/company-information/facts-and-figures Accessed on: 5/10/2015.

HEIDEGGER, M. 2010 [1927]. *Being and Time*. New York, State University of New York Press, 590 p.

KERRIDGE, T. 2015. *Designing Debate: The Entanglement of Speculative Design and Upstream Engagement*. London, UK. Doctorate Thesis. University of London.

LATOUR, B. 1987. *Science in Action: How to follow scientists and engineers through society*. Cambridge, Harvard University Press, 282 p.

LAW, J. 2004. *After Method: Mess in social science research*. London/New York, Routledge, 200 p.

LAW, J.; LIEN, M. 2013. Slippery: Field notes in empirical ontology. *Social Studies of Science*, **43**(3):363-378. https://doi.org/10.1177/0306312712456947

LE DANTEC, C.A. 2012. Participation and Publics: Supporting Community Engagement. *In:* SIGCHI 2012 Conference, Austin, Texas, 2012. *Proceedings...* SIGCHI, p. 1351-1360.

LEONARD, W.R.; ROBERTSON, M.L.; SNODGRASS, J.J.; KUZAWA, C.W. 2003. Metabolic correlates of hominid brain evolution. *Comparative Biochemistry and Physiology - A*, **136**(1):5-15. https://doi.org/10.1016/S1095-6433(03)00132-6

MARRES, N. 2013. Why political ontology must be experimentalized: On eco-show homes as devices of participation. *Social Studies of Science*, **43**(3):417-443. https://doi.org/10.1177/0306312712475255

MOL, A. 1999. Ontological politics. A word and some questions. *In:*

J. LAW; J. HASSARD (eds.), *Actor Network Theory and After*. Oxford/Malden, Blackwell Publishers, p. 74-89. https://doi.org/10.1111/j.1467-954X.1999.tb03483.x

MOL, A. 2002. *The Body Multiple: Ontology in Medical Practice*. Durham/London, Duke University Press, 216 p. https://doi.org/10.1215/9780822384151

MOL, A. 2013. Mind your plate! The ontonorms of Dutch dieting. *Social Studies of Science*, **43**(3):379-396. https://doi.org/10.1177/0306312712456948

NOLD, C. 2015. Micro/macro prototyping. *International Journal of Human-Computer Studies*, **81**(C):72-80. https://doi.org/10.1016/j.ijhcs.2015.02.004

NOLD, C. 2017. *Device Studies of Participatory Sensing: Ontological Politics and Design Interventions*. London, Doctorate Thesis, UCL.

NOLD, C. 2018. Turning Controversies into Questions of Design: Prototyping Alternative Metrics for Heathrow Airport. *In:* N. MARRES; M. GUGGENHEIM; A. WILKIE (eds.), *Inventing the Social*. Manchester, Mattering Press, p. 94-124.

OUDSHOORN, N.; PINCH, T. (eds.). 2006. *How Users Matter: The Co-Construction of Users and Technology*. Cambridge, MIT Press, 352 p.

PINCH, T.J.; BIJKER, W.E. 1984. The Social Construction of Facts and Artefacts: or How the Sociology of Science and the Sociology of Technology might Benefit Each Other. *Social Studies of Science*, **14**(3):399-441. https://doi.org/10.1177/030631284014003004

RAMAPRASAD, A.; PAPAGARI, S. 2009. Ontological design. *In:* Conference on Design Science Research in Information Systems and Technology, 4, Philadelphia, Pennsylvania, 2009. *Proceedings...* DESRIST '09, **5**:1-5:7. https://doi.org/10.1145/1555619.1555626

RATTO, M.; WYLIE, S.A.; JALBERT, K. 2014. Introduction to the Special Forum on Critical Making as Research Program. *The Information Society*, **30**(2):85-95. https://doi.org/10.1080/01972243.2014.875767

STAR, S.L.; RUHLEDER, K. 1996. Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Information Systems Research*, **7**(1):111-134. https://doi.org/10.1287/isre.7.1.111

SUCHMAN, L. 2007. *Human-Machine Reconfigurations: Plans and Situated Actions*. New York, Cambridge University Press, 326 p.

WHATMORE, S.J. 2013. Earthly Powers and Affective Environments: An Ontological Politics of Flood Risk. *Theory, Culture & Society*, **30**(7-8):33-50. https://doi.org/10.1177/0263276413480949

WILKIE, A. 2010. *User Assemblages in Design: An Ethnographic Study*. London, UK. Doctorate Thesis. Goldsmiths, University of London.

WILLIS, A-M. 2006. Ontological Designing. *Design Philosophy Papers*, **4**(2):69-92. https://doi.org/10.2752/144871306X13966268131514

WINOGRAD, T.; FLORES, F. 1990. *Understanding Computers and Cognition: A New Foundation for Design*. Norwood, Ablex Publishing Corporation, 216 p.

WOOLGAR, S.; LEZAUN, J. 2013. The wrong bin bag: A turn to ontology in science and technology studies? *Social Studies of Science*, **43**(3):321-340. https://doi.org/10.1177/0306312713488820

WOOLGAR, S.; LEZAUN, J. 2015. Missing the (question) mark? What is a turn to ontology? *Social Studies of Science*, **45**(3):462-467. https://doi.org/10.1177/0306312715584010

WYNNE, B. 1996. May the Sheep Safely Graze? A Reflexive View of the Expert-Lay Knowledge Divide. *In:* S. LASH; B. SZERSZYNSKI; B. WYNNE (eds.), *Risk Environment and Modernity towards a New Ecology*. London, Sage Publications, p. 44-83.

Submitted on December 15, 2017
Accepted on May 19, 2018